

A Heavy Flavor Tracker for STAR

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We propose to construct a Heavy Flavor Tracker (HFT) for the STAR experiment at RHIC. The HFT will bring new physics capabilities to STAR and it will significantly enhance the physics capabilities of the STAR detector at central rapidities.

The primary motivation for the HFT is to extend STAR's capability to measure heavy flavor production by the measurement of charm and beauty decays that are displaced from the collision vertex. The primary physics topics to be addressed by the HFT include open charm measurements, light quark thermalization, heavy quark energy loss and flow.

The most exciting measurement with the pixel detector is to perform a measurement of the elliptic flow of D mesons down to very low p_T values. Elliptic flow is established in the early, most likely partonic phase. If charm quarks, with a mass much larger than the temperature of the system, acquire elliptic flow then it has to come from many collisions with the abundant light quarks. Thus, flow of charm quarks can be taken to be a measure of frequent re-scatterings of light quarks and thus is an indication of thermalization if it is achieved in the early stages of heavy ion collisions at RHIC. Thermalization is important because we believe that probing the degree of thermalization constitutes the last step towards the establishment of the QGP at RHIC.

The pixel detector will also allow us to measure the ratio of different D meson states with high precision. This measurement can be used to test if the different states are produced in the same ratio as in elementary particle collisions or if the ratios are established according to heavy quark kinetic equilibration.

The heavy quarks can also be used to probe other properties of the medium created in heavy ion collisions. The production of gluons is kinematically suppressed for heavy flavors (due to the dead cone effect) and as a consequence heavy flavors should lose less energy in the dense medium.

These measurements require a very thin detector with excellent spatial resolution.

The proposed HFT detector sits inside the STAR TPC and surrounds the interaction vertex. It exploits all of STAR's unique features including full azimuthal coverage and tracking from the lowest p_T to the highest. The HFT has two tracking layers composed of monolithic CMOS pixel detectors using $30 \mu\text{m} \times 30 \mu\text{m}$ square pixels. These critical in-

nermost tracking layers lie at radii of 1.5 cm and 5 cm, respectively, and these layers are active over 20 cm in Z and have ~ 100 Million active pixels. The HFT will provide tracking information for decaying particles that are displaced by only ~ 100 microns from the primary vertex. The silicon chips for the detector will be thinned to $50 \mu\text{m}$ and will be mounted on low mass carbon fiber structures to minimize pointing errors generated by multiple Coulomb scattering. In this respect, the STAR HFT is unique. No other Si detector at RHIC combines this kind of extreme pointing accuracy and can do it for all particles down to 150 MeV/c.

The HFT detector will bring extremely high precision tracking capabilities to STAR with a point resolution of less than $10 \mu\text{m}$, over a large pseudo-rapidity range, and complete azimuthal angular coverage. The HFT will enable STAR to perform high precision measurements of heavy-quark production over the broadest range of phase space, colliding system sizes, and energies.

We propose to build and install the detector over a three year period and we plan to have it ready in time to take data in the next full energy Au+Au run at RHIC.

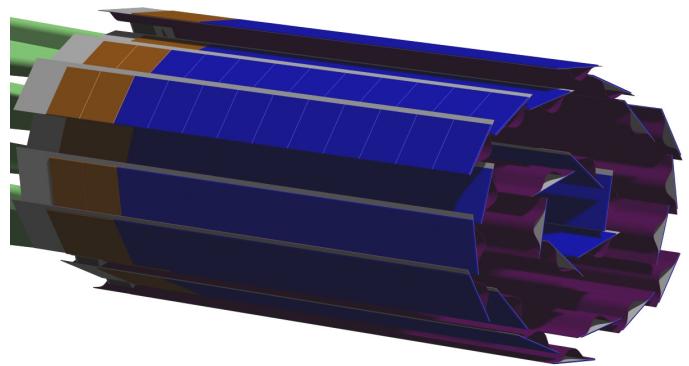


FIG. 1: Approximately 100 million pixels are shown laid out on 10 chips per ladder and arranged at 2 different radii around the beam pipe at 1.5 and 5.0 cm, respectively.

REFERENCES

- [1] *A Heavy Flavor Tracker for STAR*, A proposal submitted to the STAR Collaboration , LBNL/PUB-5509 (2005).